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(54) High-pressure discharge lamps having improved lead-through foils

(57) The lead-through foil 14 (e.g. Mo or W) in the pinch seal 12 of a metal halide-containing high-pressure mercury-discharge lamp has a coating of Ta, Nb, V, Cr, Zr, Ti, Y, La, Sc or Hf preferably 0.01–0.2 μm thick which may be deposited by vapour decomposition, sputtering, electrolysis, ion plating or CVD. The gastightness of seal 12 is thereby improved. Moreover, if a part 33 of an external current conductor 20 situated in the pinch seal 12 is also formed, at least at its surface, from one of the said coating metals, it prevents alkali metals escaping from the filling inside the discharge vessel 10.

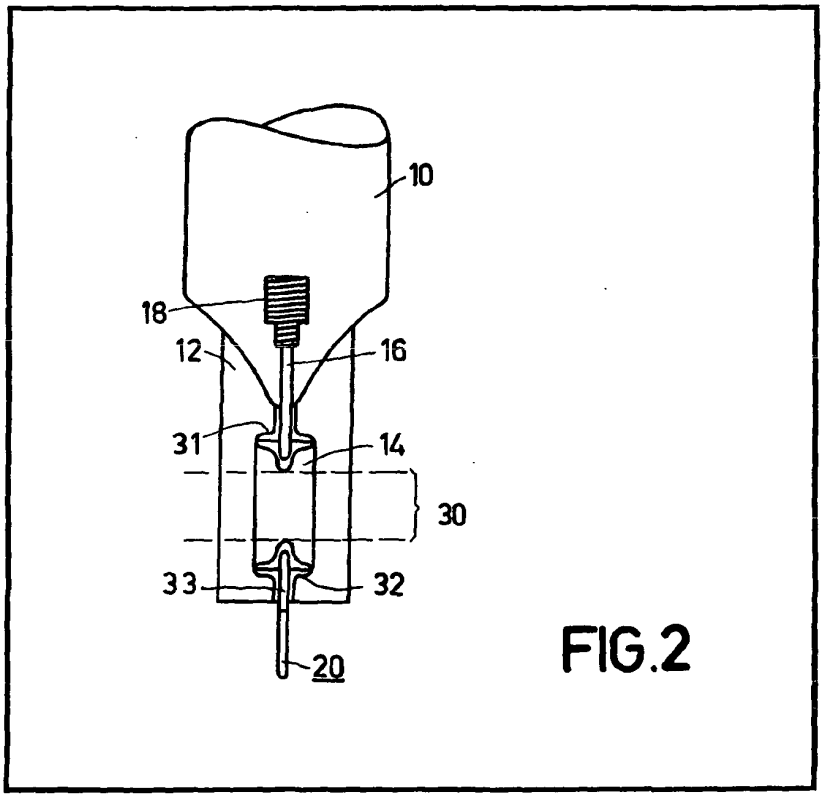

FIG.2

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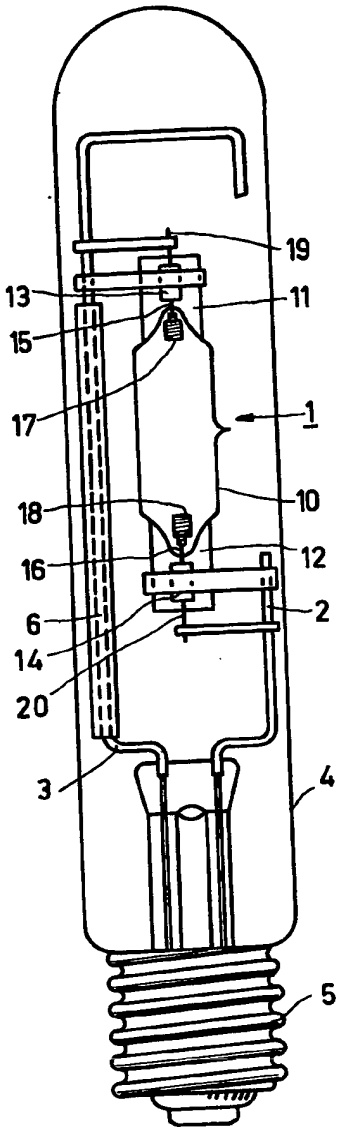

FIG.1

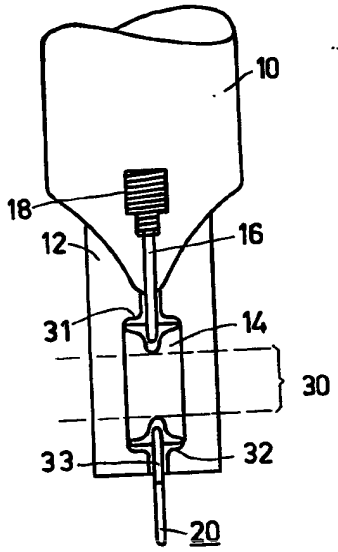

FIG.2

SPECIFICATION

High-pr ssure mercury discharge lamp

The invention relates to a high-pressure mercury discharge lamp having a sealed vacuum-tight quartz glass discharge vessel with a pinch seal, in which pinch seal a metal foil coated with a layer of a second metal is incorporated, which foil is connected to an internal current conductor secured to an electrode located inside the discharge vessel and to an external current conductor, which discharge vessel contains a filling comprising mercury, rare gas and metal halides.

Such a lamp is disclosed in United Kingdom Patent Specification 1,521,129. In the known lamp a molybdenum foil is present in the pinch seal and is coated with a layer of tungsten. The tungsten coating is provided because it is believed that metal halides are liable to penetrate into the pinch seal and to attack the molybdenum foil, so destroying the adhesion of the quartz glass to the molybdenum foil. A 2μm thick tungsten layer on the foil has been proposed for the purpose of preventing or mitigating attack of the foil. The tungsten layer would preferably be up to ten or more μm thick, provided the overall thickness of the foil does not impede the formation of a vacuum-tight pinch.

During the investigations which led to the invention, it was found that the coating of molybdenum foils with tungsten did not constitute an entirely reliable means of preventing the premature failure of high-pressure mercury lamps containing a metal halide in the lamp filling.

It is the object of the invention to provide metal halide-containing high-pressure mercury lamps in which the gas tightness of the pinch seal is improved.

The invention provides a high-pressure mercury discharge lamp having a sealed vacuum-tight quartz glass (as hereinafter defined) discharge vessel with a pinch seal, in which pinch seal a metal foil coated with a layer of a second metal is incorporated, to which coated foil an internal current conductor secured to an electrode located inside the discharge vessel and an external current conductor are connected, which discharge vessel contains a filling comprising mercury, rare gas and metal halides, characterised in that the second metal is one of the metals Ta, Nb, V, Cr, Zr, Ti, Y, La, Sc and Hf.

When such coated foils are used, the economical life of the lamp is determined by the reduction of the luminous efficiency as a result of the formation of blackening on the wall of the lamp envelope.

The inv ntion is based on a hypoth sis which will be explained below.

The pinch seal of a high-pressure mercury discharge lamp, immediately aft r its manufacture, is vacuum-tight over the part f the length of the m tal foil situated b tw en th nd f th internal curr nt conduct r and th end of the external current conduct r. A capillary duct extends around the two current conductors in the pinch seal. Components from the filling of the lamp envelope can penetrate through the duct around the internal current conductor to the foil in the pinch, and constituents from the atomsphere surrounding the lamp envelope can penetrate to the foil in the pinch through the duct around the external current conductor.

Both molybdenum foils and tungsten foils enter into consideration to be used as metal foils in pinch seals. Both materials have natural oxide skins which is important for producing good adhesion between quartz glass and the foil.

High-pressure mercury lamps with metal halides comprise one or more alkali metals, for example sodium and lithium, and one or more other metals, for example indium, thallium, scandium, cadmium, zinc, lead and tin from group IIB, IIIA, IIIB and IVB of the periodic table.

According to the hypothesis underlying the invention the following reactions may occur in the pinch seal:

$$2\,SiO_2 + MoO_2 + 4NaX \rightleftarrows 2\,Na_2SiO_3 + MoX_4 \qquad (1)$$

$$MoX_4 + 4In \rightleftarrows Mo + 4InX \qquad (2)$$

where X is a halogen.

Herein Na is a representative of the alkali metals, In is a representative of the other metals and X is, for example iodine. The equilibrium (1) is situated strongly to the left because the change of the free enthalpy is positivie ($\Delta G_1 > 0$). The equilibrium (2), however, is situated very strongly to the right, because $\Delta G_2 \ll 0$. Both reactions occur in the lamp because $\Delta G_1 + \Delta G_2 < 0$. Contrary to what is said in the above-mentioned United Kingdom Patent Specification the effect of these reactions is not erosion of the molybdenum foil, but a reduction of the oxide skin thereof which leads to reduced adhesion between the foil and the quartz glass, and leakage of the lamp envelope. Furthermore, the reactions result in the formation of sodium silicate from which cristobalite is easily formed, a crystalline form of quartz having a low mechanical strength. The formation of cristobalite may result in the pinch seal cracking.

It has been found that these reactions also occur, albeit that their deleterious effect on the gas-tightness of the seal occurs more slowly, if the concentration of a metal, such as indium, in the gas mixture is very low, for example, wh n excess halogen is present. In that case, free indium may be formed in the lamp by discharge of ions at th electrod s.

According to the invention, by separating the metal foil from the quartz glass by the interposition of a second metal, the occurrence of the reaction (1) is made impossible. However, the second metal should have an oxide skin so as to produce a good adhesion to the quartz glass. In addition, the second metal should not enter into a reaction similar to reaction (1). The second metals used according to the invention consequently have such a stable oxide that when using these metals $\Delta G_1 \ll 0$ and $\Delta G_1 + \Delta G_2 > 0$. Tungsten does not fulfil this requirement. The metal foils coated with a second metal need not be subjected to any apecial treatment to form an oxide skin thereon. The oxide skin is produced in the normal processes of manufacturing a lamp, as is the case also in non-coated foils of molybdenum or tungsten.

Some of the metal halides used in high-pressure mercury discharge lamps are strongly hygroscopic. In order to avoid the introduction of water, therefore, instead of the metal halide being intorduced as such into the lamp, the metal plus mercury halide is introduced into the lamp, and the metal halide is formed with in the lamp envelope at an elevated temperature. However, it is then substantially impossible to dose metal and halogen in the stoichiometric ratio.

Since in a lamp according to the invention, a metal such as indium, can no longer exert any detrimental effect on the adhesion of quartz glass to the metal foil, such metals can now be dosed in an excess with respect to halogen. The favourable effect thereof is that, once the lamp has been at a high temperature, that is to say, once the lamp has been operated, no mercury halide is present in the lamp. It is known that very low partial pressures of a mercury halide increases the ignition voltage and the reignition voltage of a lamp. The use of an excess of metal may also serve to prevent mercury halide being formed during the life of the lamp as a result of reaction of the filling of the lamp envelope with contaminations from the wall thereof.

In one aspect of the invention, the part of the external conductor present in the pinch seal consists at least at the surface of one of the metals Ta, Nb, V, Cr, Zr, Ti, Y, La, Sc and Hf. Of course, it is possible to coat the part of the external current conductor projecting outside the lamp envelope, with such a metal or to use an external current conductor which consists entirely or for the part present in the pinch seal of one or more of the said metals. Generally, the thickness of the coating will be chosen to be at least 0.01μm. The advantage of this embodiment is that alkali metal silicate formation around the external current conductor is avoided. It has in fact been found that alkali metals (for example sodium and lithium) are capable of migrating along the interface of the metal foil and the quartz glass to the external current conductor without imparing the adhesion between the components of the seal. Although this migration and the formation of the alkali metal silicate does not result in untightness of the pinch seal because a capillary space is already present around the external current conductor, these processes do withdraw alkali metal from the discharge vessel. Consequently, the colour of the discharge may vary during the life of the lamp.

It has surprisingly been found that very thin layers of second metal on the metal foil produce the desired effect. Generally, layers of the second metal are used which are from 0.01 to 0.2μm thick, in particular from 0.05–0.1μm thick.

The coating may be obtained *inter alia* by vapour deposition, sputtering, electrolysis, ion plating or chemical vapour deposition.

Since attack of the pinch seal of the discharge vessel does not occur only when the discharge vessel consists of fused silicon dioxide, but also when glasses having a silicon dioxide content of at least 95% by weight are used, and the invention also applies thereto, quartz glass is to be understood to mean herein glass having a silicon dioxide content of at least 95% by weight.

An embodiment of a lamp acording to the invention will now be described with reference to the Example, and to the drawing, in which:–

Figure 1 is a side elevation of a high-pressure mercury discharge lamp according to the invention, and

Figure 2 shows part of the discharge vessel and a pinch seal of the lamp shown in Fig. 1, on an enlarged scale.

In Fig. 1, a discharge lamp 1 includes a discharge vessel 10 disposed between current supply conductors 2 and 3 in an outer envelope 4 which has a lamp cap 5. Current supply conductor 3 is surrounded by a ceramic tube 6. The discharge vessel 10 consists of quartz glass and is sealed by pinch seals 11 and 12 in which metal foils 13 and 14, respectively, are incorporated. Internal current conductors 15 and 16 are respectively welded to the metal foils 13 and 14 and the foils 13 and 14 are also welded to external current conductors 19 and 20, respectively. Electrodes 17 and 18 accommodated inside the lamp vessel are welded to the internal current conductors 15 and 16.

In Fig. 2, reference numeral 30 denotes a zone in the pinch seal 12 between the ends of the internal current conductor 16 and the external current conductor 20 in which the pinch seal 12 is vacuum-tight throughout its width. Capillary spaces 31 and 32, respectively extend around the internal current conductor 16 and around the external current conductor 20. The external current conductor 20 can contact oxygen and moisture from the air and is oxidised over all its length imm di-

ately after the manufacture of the pinch seal 12 while it is still at a high temperature. The external current conductor 20 consists of molybdenum. A part 33 of the external current conductor 20 which is situated in the pinch seal 12 and which may be in contact with the quartz glass is coated with tantalum. The foil 14 also consists of tantalum-coated molybdenum.

EXAMPLE:

In a practical case a quartz glass discharge vessel was filled with 36 mg of Hg, 5330 Pa Ar, 30 mg NaI, 3.7 mg TlI, 0.3 mg InI and 2 mg In. The molybdenum foils and the molybdenum external current conductors of the lamp were coated with 0.05μm Ta. During operation at 220 V, the lamp consumed a power of 400 W. The pinch seals of the lamp remained vacuum-tight and formation of cristobalite was not observed.

CLAIMS

1. A high-pressure mercury discharge lamp having a sealed vacuum-tight quartz glass (as hereinbefore defined) discharge vessel with a pinch seal, in which pinch seal a metal foil coated with a layer of a second metal is incorporated to which coated foil an internal current conductor secured to an electrode located inside the discharge vessel and an external current conductor are connected, which discharge vessel contains a filling comprising mercury, rare gas and metal halides, characterised in that the second metal is one of the metals Ta, Nb, V, Cr, Zr, Ti, Y, La, Sc and Hf.

2. A high-pressure mercury discharge lamp as claimed in Claim 1, characterised in that the part of the external current conductor situated in the pinch seal consists at least at its surface of one of the metals Ta, Nb, V, Cr, Zr, Ti, Y, La, Sc and Hf.

3. A high-pressure mercury discharge lamp as claimed in Claim 1, characterised in that the layer of the second metal is between 0.01 and 0.2μm thick.

4. A high pressure mercury discharge lamp substantially as herein described with reference to the Example and to the drawing.

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